

## **PROCESS FOR PRODUCING A CYLINDER BLOCK WITH A SLEEVE**

### **CROSS-REFERENCE TO RELATED APPLICATIONS**

**[0001]** This nonprovisional application claims priority under 35 U.S.C. § 119(a) on Patent Application No. 2002-266034, filed in Japan on September 11, 2002, the entirety of which is incorporated herein by reference.

### **BACKGROUND OF THE INVENTION**

1. Field of the Invention:

**[0002]** The present invention relates to a process for producing a cylinder block with a sleeve. In particular, the present invention relates to a process for producing a cylinder block with a sleeve, which includes forming arc recesses for avoiding interference with the umbrella portions of valves mounted in a cylinder head at an intersection between a deck face joined to the cylinder head and a cylinder bore.

2. Description of Background Art:

**[0003]** Japanese Laid-open Patent Application No. 61-124772 has disclosed a cylinder block with a sleeve. In this document, an engine includes a suction port formed therein to a maximum diameter. The suction port is opened or closed by suction valves having a large-diameter umbrella portion to enhance the filling efficiency of the engine. When the umbrella portions are advanced into the cylinder bore by the opening of the suction

valves, arc recesses are formed at an intersection between the deck face of a cylinder block and the cylinder bore to avoid interference with the deck face of the cylinder block and further to prevent the reduction of suction by a masking effect due to a small clearance in other background art engines. In the production of the cylinder block with a sleeve of the above background art document, the cylinder block is cast while it contains the sleeve and then arc recesses are formed by cutting at an intersection between the deck face of the cylinder block and the cylinder bore.

**[0004]** However, as described above, much time and labor are required to cut the above recesses after the casting of the cylinder block. This makes it difficult to reduce the production cost of the cylinder block with a sleeve.

#### **SUMMARY OF THE INVENTION**

**[0005]** It is an object of the present invention, which has been made in view of the above situation, to provide a process for producing a cylinder block with a sleeve, wherein the step of forming the recesses is performed at the time of casting the cylinder block to avoid the necessity of the post-processing of the recesses. This makes it possible to the cut production cost of the engine.

**[0006]** To attain the above object, in the production of a cylinder block with a sleeve in which arc recesses for avoiding interference with the umbrella portions of valves mounted in a cylinder head are formed at an intersection between a deck face joined to the cylinder head and a cylinder bore, the first feature of the present invention includes the steps of casting the sleeve such that it is embedded in the cylinder block with a space from the deck face simultaneously with the formation of the open end portion of the cylinder bore and the above recesses in the space using a bore pin mated with the sleeve to support the sleeve.

**[0007]** According to the first feature, the above arc recesses are formed by using the bore pin mated with the sleeve simultaneously with the casting of the cylinder block containing the sleeve. This makes it possible to simplify the production process by avoiding

the necessity of the post-processing of the recesses after the casting of the cylinder block and to greatly cut the production cost of the engine.

**[0008]** The second feature of the present invention is in addition to the first feature, and includes the step of making the sleeve and the cylinder block from an aluminum alloy.

**[0009]** According to the second feature, the diffusion of the raw materials occurs effectively at the boundary between the sleeve and the cylinder block at the time of casting the cylinder block. Accordingly, the sleeve and the cylinder block are assembled together without fail to enhance the heat conductivity of the cylinder block with a sleeve.

**[0010]** Further scope of applicability of the present invention will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

**[0011]** The present invention will become more fully understood from the detailed description given hereinbelow and the accompanying drawings which are given by way of illustration only, and thus are not limitative of the present invention, and wherein:

**[0012]** Figure 1 is a longitudinal sectional view of the key section of an engine having a cylinder block with a sleeve produced by the process of the present invention;

**[0013]** Figure 2 is a cross-sectional view along the line 2-2 of Figure 1;

**[0014]** Figure 3 is a diagram for explaining a process for producing the above cylinder block with a sleeve according to the present invention;

**[0015]** Figure 4 is a bottom view of a bore pin used for the above production according to the present invention; and

**[0016]** Figure 5 is a cross-sectional view along the line 5-5 of Figure 4.

## **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS**

**[0017]** Preferred embodiments of the present invention will now be described with reference to the accompanying drawings.

**[0018]** Referring to Figures 1 and 2, the construction of the engine having a cylinder block with a sleeve produced by the process of the present invention will be described.

**[0019]** The engine E comprises a cylinder block 1 having a cylinder bore 4 and a water jacket 7. A cylinder head 2 is joined to the deck face 5. The cylinder bore 4 is opened toward the deck face 5 of the cylinder block 1 through a gasket 3. A sleeve 6 is cast such that it is embedded in the cylinder block 1 with a predetermined space S from the deck face 5. The cylinder bore 4 includes the inner face 4a of the sleeve 6 and a bore opening end portion 4b formed on the cylinder block 1 in the above space S in such a manner that it is continuous to the inner face 4a of the sleeve 6.

**[0020]** A combustion chamber 10 facing the cylinder bore 4, a suction port 11 and an exhaust port 12 are formed in the cylinder head 2. The suction port 11 and the exhaust port 12 are arranged in the shape of a fork and are opened into the combustion chamber 10. Valve seats 13 and 14 are secured to fork end portions of the suction port 11 and the exhaust port 12, which are opened to the combustion chamber 10. Furthermore, a pair of poppet suction valves 15 and a pair of poppet exhaust valves 16 for opening and closing the suction port 11 and the exhaust port 12 in cooperation with the valve seats 13 and 14 are mounted in the cylinder head 2, respectively. It should be noted that only one poppet suction valve 15 and one poppet suction valve 16 is illustrated in Figure 1.

**[0021]** The suction port 11 and the umbrella portions 15a of the suction valves 15 have a larger diameter than the exhaust port 12 and the umbrella portions 16a of the exhaust valves 16 to enhance filling efficiency. Part of the deck face 5 of the cylinder block 1 exists within the plane of projection in the opening and closing direction of the umbrella portions

15a of the suction valves 15. Therefore, when the umbrella portions 15a and 15a are advanced into the cylinder bore 4 to open the pair of suction valves 15 and 15, the umbrella portions 15a and 15a would interfere with the deck face 5 of the cylinder block 1. To avoid this interference, a pair of recesses 17 and 17 in the shape of an arc is formed from the deck face 5 to the bore opening end portion 4b.

**[0022]** The process for producing a cylinder block 1 with a sleeve having the above recesses 17 and 17 will now be described with reference to Figures 3 to 5.

**[0023]** An aluminum alloy sleeve 6 is first prepared. The inner diameter of the sleeve 6 is set smaller than the normal inner diameter of the above cylinder bore 4, taking into account post-processing length.

**[0024]** A bore pin 20 for supporting the sleeve 6 is mated with the sleeve 6. As shown in Figures 4 and 5, the bore pin 20 has a cylindrical large-diameter portion 23 having a slightly larger diameter than a sleeve mating portion 21. The large-diameter portion 23 is continuous to the sleeve mating portion 21 through a ring stepped portion 22 and a pair of arc projections 24 and 24 projecting from the peripheral surface of the large-diameter portion 23. The large-diameter portion 23 corresponds to the shape of the above bore opening end portion 4b, and the projections 24 and 24 correspond to the shape of the above recesses 17 and 17. The cylindrical sleeve mating portion 21 mates with the sleeve 6. Furthermore, a cooling water jacket 27 is formed at the center of the bore pin 20.

**[0025]** The sleeve 6 is then set in the metal mold 25 of a casting machine, for example, a die cast machine together with the bore pin 20. The metal mold 25 includes a first mold 25a having a cavity 26 for molding the cylinder block which stores the sleeve 6 and a second metal mold 25b for closing the opening end face of the cavity 26. The inner face of the second metal mold 25b corresponds to the above deck face 5. Therefore, to set the sleeve 6 in the cavity 26 of the first metal mold 25a, the sleeve 6 is sunken in the cavity 26 by a distance corresponding to the above space S from the inner face of the second metal mold 25b. Thereafter, a molten aluminum alloy is filled into the cavity 26, whereby the

cylinder block 1 containing the sleeve 6 is molded. At the same time, the above bore opening end portion 4b and the above recesses 17 and 17 are molded in the cylinder block 1 using the large-diameter portion 23 and the projections 24 and 24 of the bore pin 20, respectively.

**[0026]** After the cylinder block 1 with a sleeve is cast, the inner face 4a of the sleeve 6 and/or the bore opening end portion 4b is cut to form a normal cylinder bore 4 having a uniform diameter.

**[0027]** Since the arc recesses 17 and 17 are molded using the bore pin 20 mated with the sleeve 6 simultaneously with the casting of the cylinder block 1 containing the sleeve 6, it is possible to simplify the production process by avoiding the necessity of the post-processing of the recesses 17 and 17 after casting and to greatly cut the production cost.

**[0028]** Since the sleeve 6 made from an aluminum alloy is embedded in the cylinder block 1 made from an aluminum alloy, the diffusion of the raw materials into each other occurs effectively at the boundary between the sleeve 6 and the cylinder block 1. Accordingly, the sleeve 6 and the cylinder block 1 are assembled together without fail to enhance the heat conductivity of the cylinder block 1 with a sleeve.

**[0029]** The present invention is not limited to the above embodiment and various design changes and modifications may be made without departing from the scope of the present invention. For example, the present invention can be applied to a situation where it is necessary to avoid interference between the umbrella portions 16a of the exhaust valves 16, if formed to a maximum diameter, and the deck face 5 of the cylinder block 1. In other words, it is also possible to form arc recesses 17 and 17 at an intersection between the deck face 5 and the cylinder bore 4 in order to avoid interference between the umbrella portions 16a of the exhaust valves 16 and the deck face 5 of the cylinder block 1.

**[0030]** According to the first feature of the present invention, in order to produce a cylinder block with a sleeve in which arc recesses for avoiding interference with the umbrella portions of valves mounted in a cylinder head are formed at an intersection between a deck

face joined to the cylinder head and a cylinder bore, the sleeve is cast such that it is embedded in the cylinder block with a space from the deck face. At the same time, the opening end portion of the cylinder bore and the recesses are molded in the cylinder block in the above space using a bore pin mated with the sleeve to support the sleeve. Therefore, the arc recesses can be molded with the bore pin simultaneously with the casting of the cylinder block containing the sleeve. Consequently, it is possible to simplify the production process by avoiding the necessity of the post-processing of the recesses after the casting of the cylinder block and to greatly cut the production cost.

**[0031]** According to the second feature of the present invention, in addition to the above first feature, the sleeve and the cylinder block are made from an aluminum alloy. Accordingly, diffusion of the raw materials into each other occurs effectively at the boundary between the sleeve and the cylinder block at the time of casting the cylinder block. In view of this, the sleeve and the cylinder block are assembled together without fail to enhance the heat conductivity of the cylinder block with a sleeve.

**[0032]** The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.